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福島第一原子力発電所事故によって海洋に漏洩したCs-137の海洋中の長期間の挙動
Long-term behavior of Cs-137 activity in the ocean following the Fukushima Daiichi Nuclear Power Plant Accident

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A series of accidents at the Fukushima Dai-ichi Nuclear Power Plant following the earthquake and tsunami of 11 March 2011 resulted in the release of radioactive materials to the ocean by two major pathways, direct release from the accident site and atmospheric deposition.

We reconstructed spatiotemporal variability of Cs-137 activity in the ocean by the comparison model simulations and observed data. We employed a regional scale and the North Pacific scale oceanic dispersion models, an atmospheric transport model, a sediment transport model, a dynamic biological compartment model for marine biota and river runoff model to investigate the oceanic contamination.

Direct releases of Cs-137 were estimated for two years and six months after the accident by comparing simulated results and observed activities very close to the site. The estimated total amounts of directly released was 3.6±0.7 PBq. Directly release rate of Cs-137 decreased exponentially with time by the end of December 2012 and then, was almost constant. The daily release rate of Cs-137 was estimated to be 3.0 x 10^10 Bq/day by the end of September 2013. The activity of directly released Cs-137 was detectable only in the coastal zone after December 2012. Simulated Cs-137 activities attributable to direct release were in good agreement with observed activities, a result that implies the estimated direct release rate was reasonable, while there is no observed data of Cs-137 activity in the ocean from 11 to 21 March 2011. Observed data of marine biota should reflect the history of Cs-137 activity in this early period. We reconstructed the history of Cs-137 activity in this early period by considering atmospheric deposition, river input, rain water runoff from the 1F NPP site and absorption in sediment. The comparisons between simulated Cs-137 activity of marine biota by a dynamic biological compartment and observed data also suggest that simulated Cs-137 activity attributable to atmospheric deposition was underestimated in this early period. In addition, river runoff model simulations suggest that the river flux of Cs-137 to the ocean was effective to the Cs-137 activity in the ocean in this early period. The sediment transport model simulations suggests that the inventory of Cs-137 in sediment was less than 10% of total released Cs-137. Sediment is not dominant sink of Cs-137 in the ocean.

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